Atmospheric Composition Constellation

Ernest Hilsenrath
NASA/HQ

ESIP

Washington, DC

31 October 2007

Atmospheric Composition Constellation (ACC)

- **The Atmospheric Composition (AC) Constellation is one of four pilot projects established by CEOS <u>to bring about technical/scientific collaboration</u> among space agencies that support national priorities and the GEO SBA's**

- **The AC Constellation study will <u>identify mission(s) or data delivery</u> that serves the science and application community that can be advocated by the CEOS agencies**

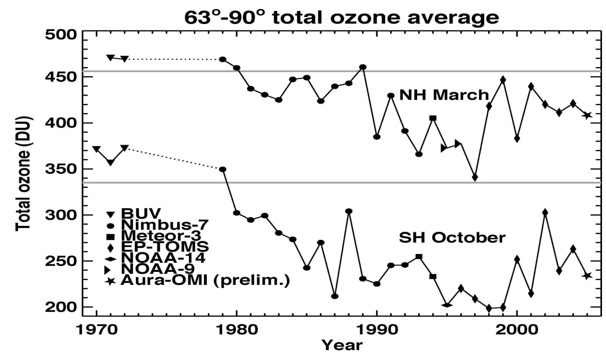
- **The AC Constellation study will prioritize user requirements and <u>define missions or a "virtual" system</u> consisting of space and ground segments to include archives and data distribution systems that meet science and application user requirements**

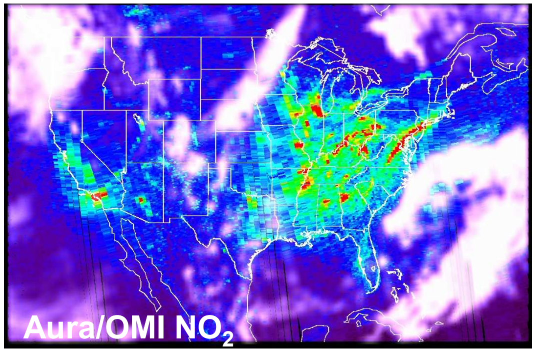
- **The AC Constellation considers only the space component of atmospheric composition science and applications, <u>but recognizes the need for complimentary ground based measurements and modeling</u> to fully address science and application priorities**

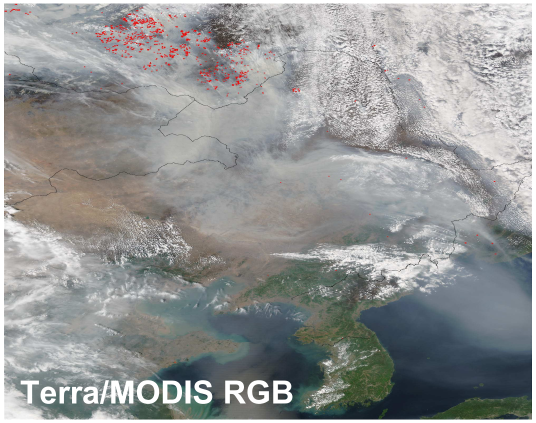
Science Questions → Applications

- How is stratospheric ozone responding to the Montreal protocol and what are the effects of climate change on expected ozone recovery?
- What are the impacts of long range transport of pollution on local and regional air-quality? How do changes in air quality effect ecosystems?
- How do changes in atmospheric composition (radiatively active gases and aerosols) affect climate? How does climate change affect atmospheric composition?

"*Observations have clearly shown that human activities are changing the composition of the Earths atmosphere. Research has demonstrated that there are important consequences of such changes for climate, human health, and the balance of ecosystems..* ", IGOS/IGACO, 2004





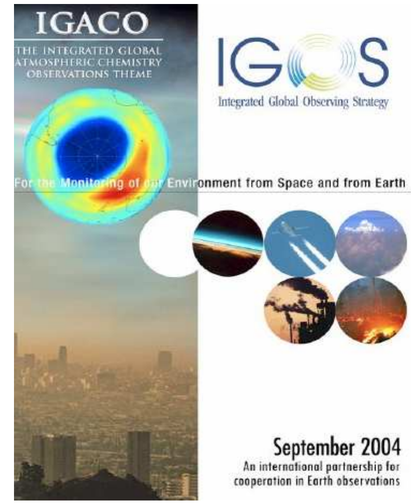


ACC Requirements are Mature

- **Requirements for Atmospheric Composition measurements have been developed and supported by national and international space agencies and panels**
  - **IGOS/IGACO (WMO), US Decadal Survey, CAPACITY, GMES, NASA Science Plan, US CCSP, ESA Living Planet, etc**
  - **Consistent with GEO SBA's and GEOSS**
  - **WMO/GOS recognizes the need for additional AC observations via GAW**
  - **GCOS Climate requirements (ECVs)**
  - **IGACO has transitioned into GEO**

- ***The AC Constellation goal*: Collect and deliver data to develop and improve predictive capabilities for coupled changes in the *ozone layer, air quality, and climate forcing* associated with changes in the environment.**

- **Three specific users types:**
  - **Forecast services: National weather and environmental protection agencies**
  - **Assessments: IPCC, Montreal Protocol, USCCSP**
  - **Monitoring: Montreal and Kyoto Protocols, IPCC, GCOS, CCSP, PROMOTE (GMES)**

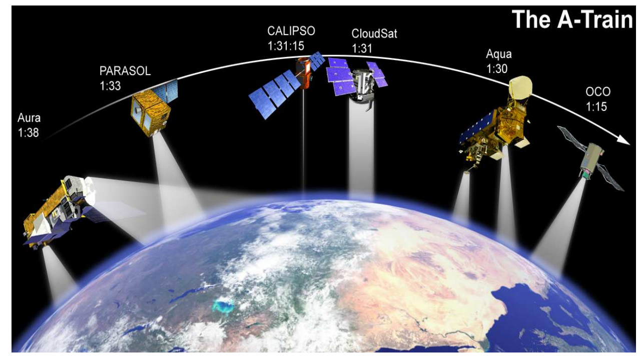


IGOS Transitions to GEO

ACC Constellation Synergy: A-Train

Unique opportunity for conducting AC science and providing Societal Benefits using multiple instruments across international platforms

- Collaboration efficiency: take advantage of each instrument's unique capability
- Cross instrument validation
- Improved spatial and temporal coverage: e.g. different equator crossing times
- Enhanced data products: e.g. aerosol and cloud characteristics, pollution and its transport for assessments and forecasting
- More accurate trends by comparing and combining data sets

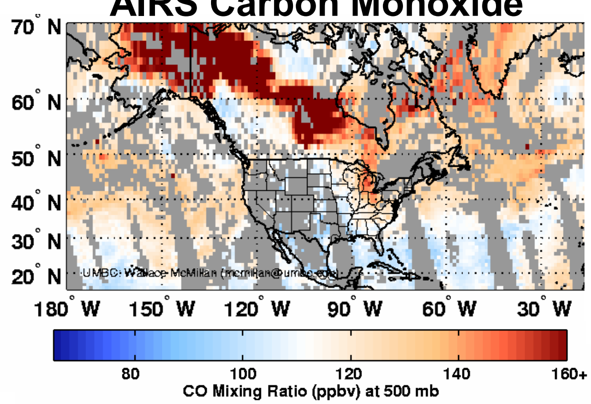


A-train is a good example of Constellation Science

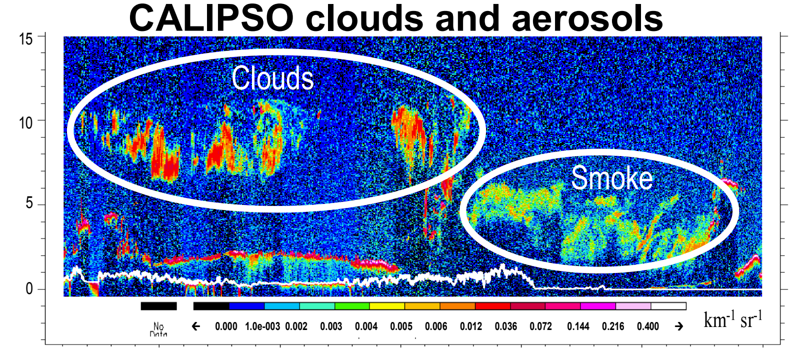
CEOS provides an opportunity to extend collaboration internationally

Example:
Geographic extent of CO from biomass burning in combination with vertical distribution of smoke improves assessment of total emissions and downstream impacts

AIRS Carbon Monoxide



CALIPSO clouds and aerosols



ACC traceability to GEO WP map into 5 SBA's

SBA	Science and Measurements	GEO 2007-2009 Work Plan	GOESS 2-year Targets	GEOSS 6-year Targets	GEOSS 10-year Targets
Disaster	**Fires**: smoke and ash **Seismicity:** volcanic ash aerosols, SO2 **Pollution events:** emissions, mapping	**DI-06-07:** Multi-hazard zonation and maps **DI-06-09:** Use of Satellites for Risk Management **DI-06-13:** Implementation of a Fire Warning System a a Global Level	Strengthening the International Charter on Space and Major Disasters and similar supporting activities. Production of an inventory of hazards zonation maps.	Facilitating real-time monitoring of volcanic activities. Expansion of the production of an inventory of hazards zonation maps.	Hyper-spectral capability for monitoring smoke and pollution plumes.
Climate	**Atmospheric Composition:** CO2, CH4, Trop O3, other GHG, and Aerosol Properties **Long term measurements:** IGOS and GCOS connections	**CL-06-02:** Key Climate Data from Satellite Systems **CL-07-01:** Seamless Weather and Climate Prediction System	Adhere to the GCOS Climate Monitoring Principles and commit to the suite of instrument, supporting research program to support development of observational capabilities for ECV's.	Development and operation of new instruments. Establishment of data archive centers for all ECVs, institutional commitment to provide integrated global analysis of all ECVs, data integration facilities for exchanging data, products and information between climate sectors and socio-economic benefit areas need to be coordinated.	New and extended re-analysis programs for atmospheric domains and implementation of an integrated observing system for atmospheric composition monitoring in support of climate policy through an optimal combination of ground-based networks, LEO and GEO satellites and models are ultimate goals.
Health	**Air Quality:** ozone precursors, particulates, SO2, allergens **Stratospheric:** ozone and UV radiation	**HE-06-03:** Forecast Health Hazards **HE-07-01:** Strengthen Observation and Information Systems for Health **HE-07-02:** Environment and Health Monitoring and Modeling **HE-07-03:** Integrated Atmospheric Pollution Monitoring, Modeling and Forecasting	New, high-resolution Earth observations relevant to health needs are advocated. Facilitating development of products and systems that integrate the Earth science database with health information	Monitoring methods and systems to detect health-related change	Early detection and control of environmental risks to human health through improvements in the sharing and integration of Earth observations, and early warning systems are required.
Energy	**Chemical forecasting:** aerosols, GHGs **Climate statistics:** aerosols, GHGs, radiation	**EN-06-04:** Using New Observation Systems for Energy **EN-07-01:** Management of Energy Sources **EN-07-02:** Energy Environmental Impact Monitoring **EN-07-03:** Energy Policy Planning	New generation of operational observing systems.	An evaluation of the observing system progress and its revision.	Implementation of operational observing systems and provision of timely data in support of energy operations.
Ecosystem	**Carbon fluxes/exchange:** CO, CO2, CH4 **Solar radiation**: UV radiation	**EC-06-01:** Integrated Global Carbon Observation (IGCO) **EC-07-01:** Global Ecosystem Observation and Monitoring Network	Facilitating full implementation of the IGOS-P Carbon (IGCO) Theme report. Facilitating a globally agreed classification scheme.	Implementation of a global nitrogen observing system.	Facilitating globally agreed spatial-resolved information on ecosystem change.

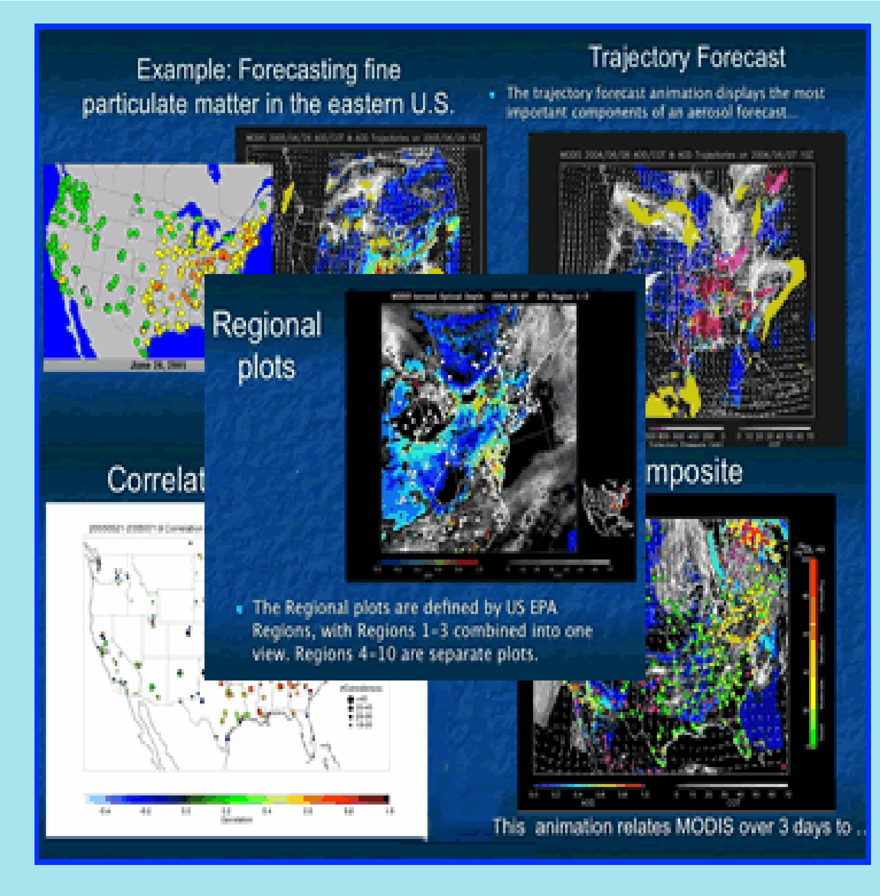
ACC Near Term projects

Short term projects will emphasize synergistic and enhanced data products from multiple mission

1. An advanced nitrogen dioxide (NO2) product using data from both GOME-2/Metop and OMI/Aura: Data from these two instruments are collected at 1030 and 1345 which could yield time of day changes for this Criteria Pollutant. This will result in improved air quality forecasts.

2. Aviation alert and control for volcanic eruptions. ESA and NASA support development of SO2 and ash products from Envisat and Aura which cover the Pacific Rim and Europe and Africa for distribution to VAACS through the meteorological service to the ICAO. Combined services resulting in more timely data and global coverage.

3. Global fire and aerosol data products for forecasts and assessment. Use the IDEA (Infusion of Satellite Data for Environmental Applications) project which is now operational http://idea.ssec.wisc.edu/). Extending the capability of developing fire, aerosol, and subsequent forecast products for global operational purposes



ACC Project – Time of day NO_2

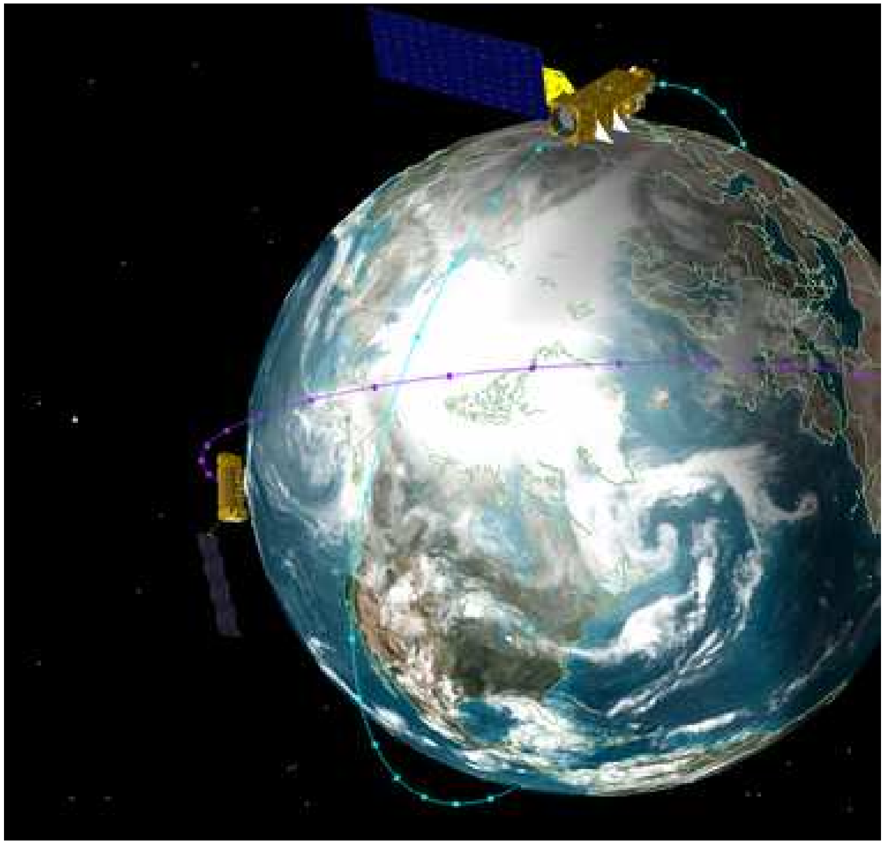
Purpose – International collaborative effort

- NO_2 is precursor to ozone and an EPA criteria pollutant
- Satellite NO_2 data will be used operationally by NOAA for forecasting air quality
- Improve emissions inventories
  - Industrial, biomass burning, lightning, and soil sources
- Characterize long range transport
- Assessment of processes
- Compliance and clean air rules
- Model and forecast improvements

ACC Project – Time of day NO_2

How?

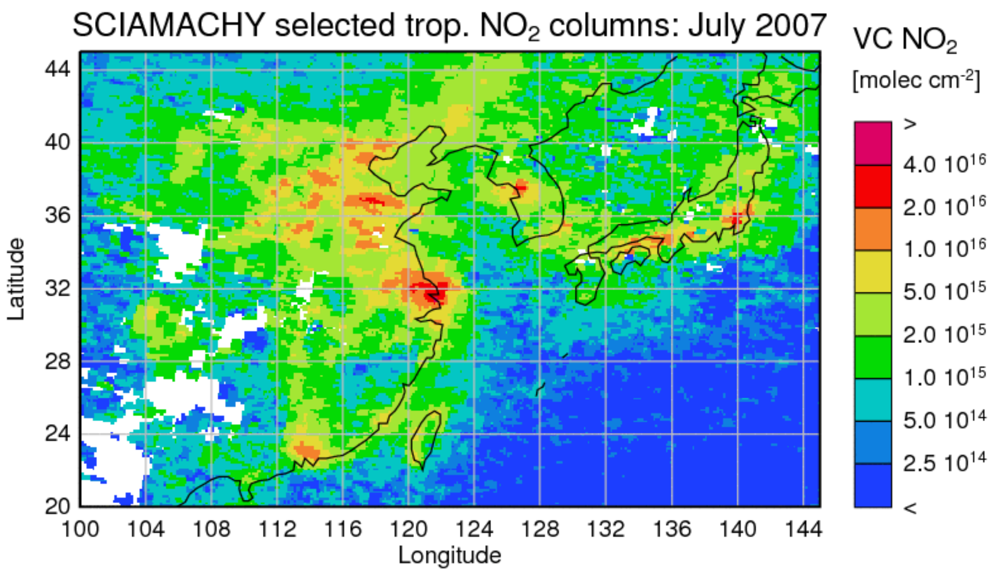
- Employ NO2 data from two satellites that have different orbital crossing times
  - Metop/GOME-2: 09:30
  - Aura/OMI: 13:45
  - CMAQ model for comparisons, simulations, and *a-priori*
  - Validation from ground data

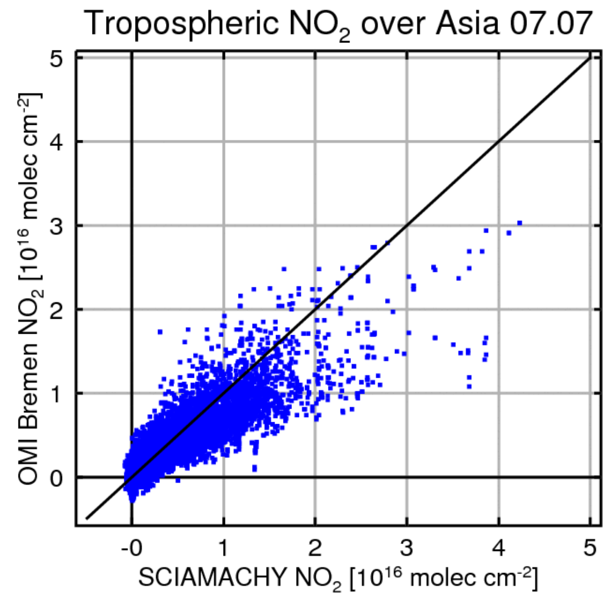


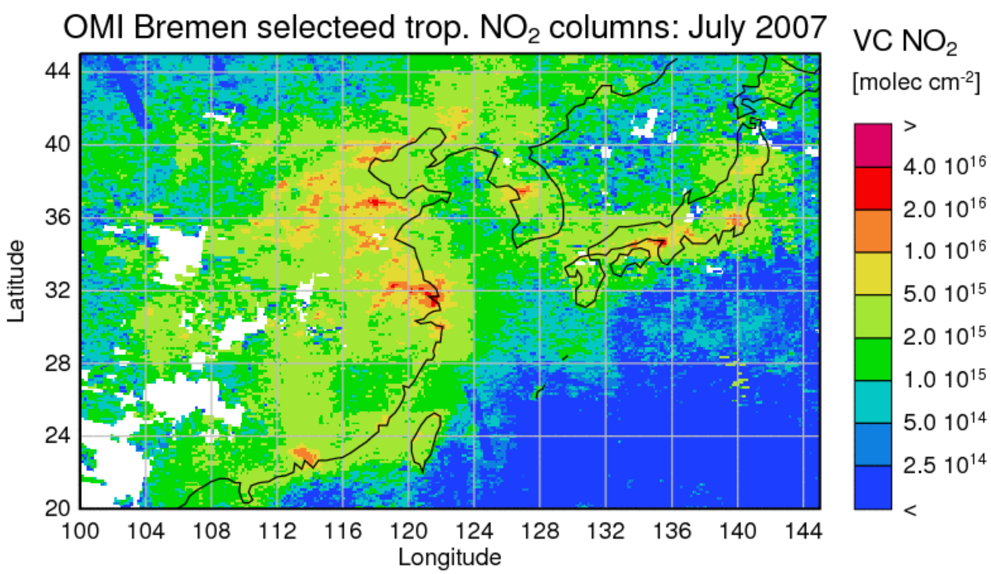
Issues

- Different Instruments
  - Footprints, coverage, calibration
- Different algorithms
  - Wavelength, *a-priori*, cloud clearing, Surface albedo, stratospheric component

OMI (1:45) vs SCIAMACHY (10:30)

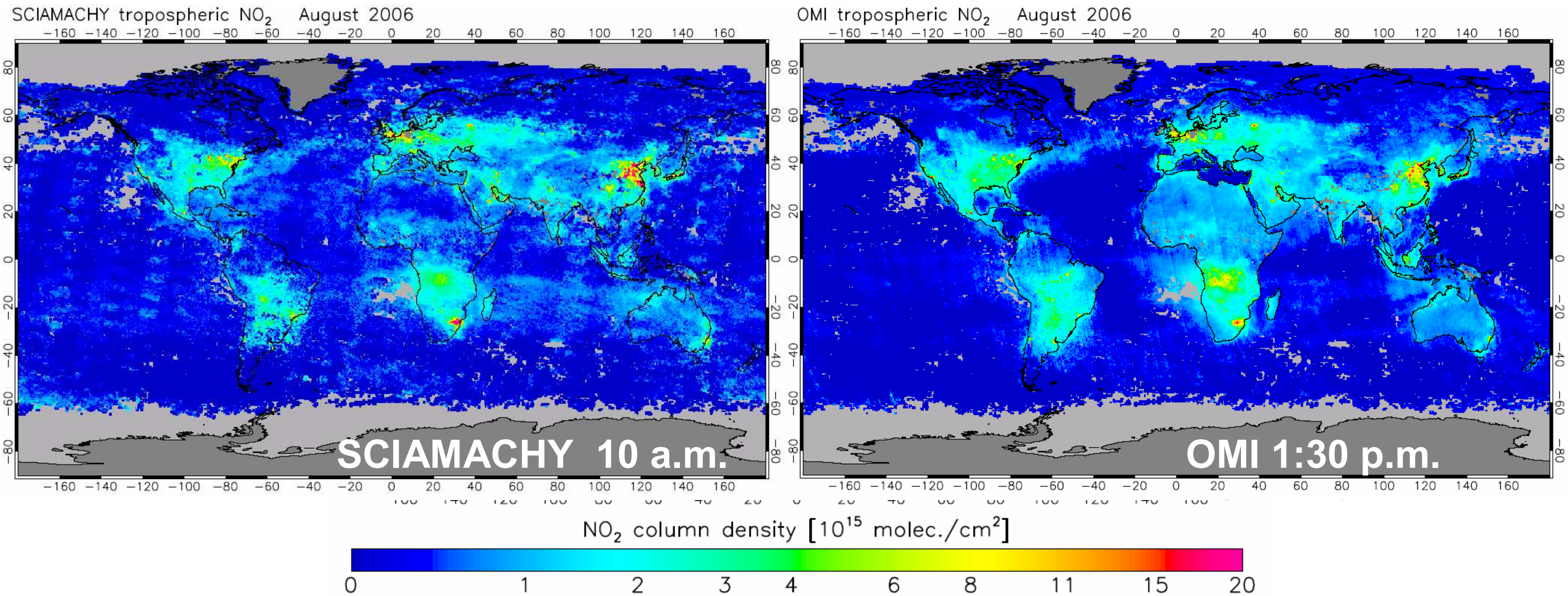


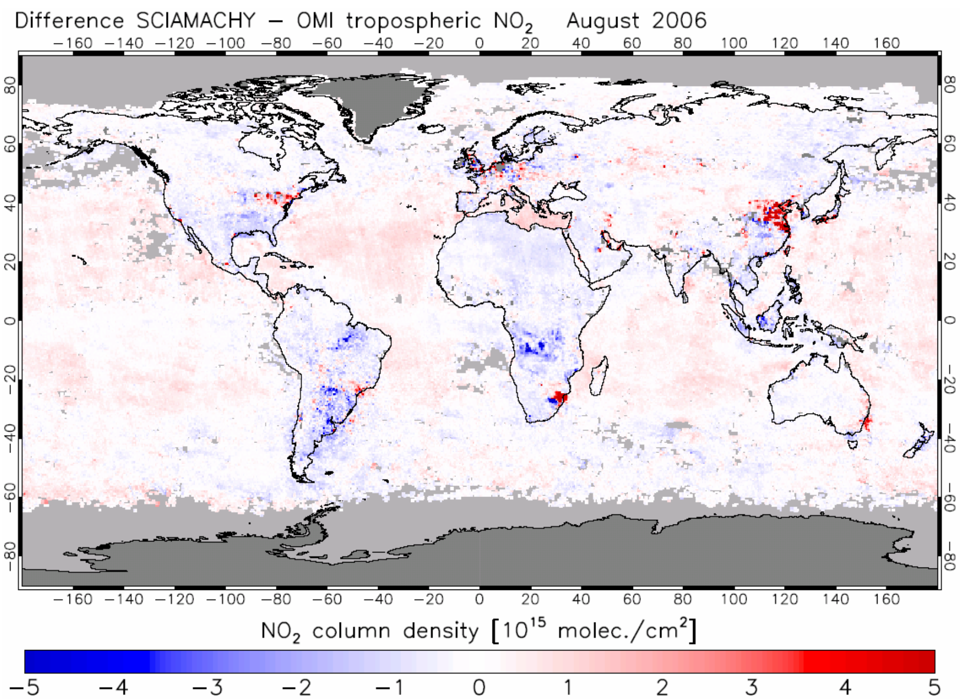




- **Good *average* agreement up to 10^{16} molec cm-2**
- **Significant scatter (~50%)**
- **OMI is lower than SCIAMACHY for larger NO_2 amounts**
- **Diurnal component?**

A. Richter, University of Bremen





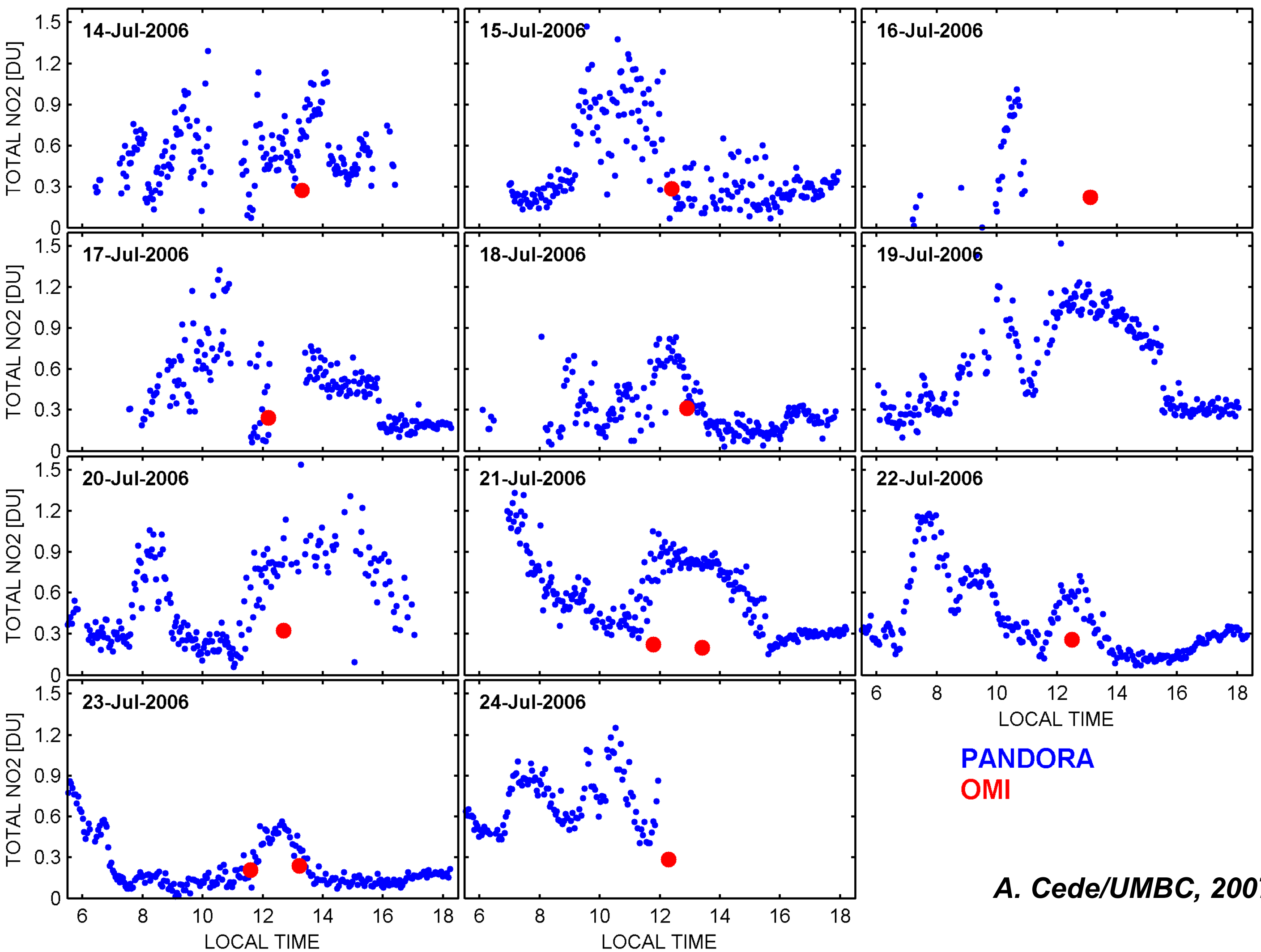
OMI-SCIAMACHY intercomparison of tropospheric NO_2 columns:

Does difference reflect variable diurnal cycle of NO_x emissions?

Need multiple return times per day with same or well inter-calibrated instruments

K.F. Boersma, in prep.

Local NO_2 Variations
Thessaloniki, Greece July 2006



A. Cede/UMBC, 2007